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RESEARCH ARTICLE.........

Experimental studies on co-culture of Shrimp, *Litopenaeus vannamei* (Boone, 1931) with sea cucumber, *Holothurian moebii* (Ludwig, 1883)

N.D. CHOGALE, R.D. BONDRE, H. SINGH, R. PAI, S.Y. METAR, S.B. SATAM AND A.D. ADSUL

ABSTRACT...... The pond waste management is a major concern of the shrimp farmers. The sea cucumber, *H. moebii* (weight: 79.35 ± 0.013 g) with juvenile white leg shrimps, *L. vannamei* (weight: 2.6 ± 0.18 g) were reared in co-culture and monoculture for 30 days in plastic tank with shrimp pond soil substratum. Shrimp feed was given as per shrimp feeding protocol. Laboratory study suggests that sea-cucumber reducing the percentage organic carbon in the soil. However, growth and survival of shrimp did not differ between monoculture and co-culture. Shrimp increased the level the level of organic carbon in monoculture as compared to co-culture. This study showed that co-culture of two species in earthen ponds appears to be improvement of soil condition of pond.

KEY WORDS...... Sea cucumber, Shrimp, Organic carbon, Soil

Author for Corresponding -

N.D. CHOGALE
Marine Biological Research Station, Zadgaon, RATNAGIRI (M.S.) INDIA
Email: narya_fish@rediffmail.com

See end of the article for **Coopted authors'**

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INTRODUCTION

Shrimp farming got bogged down due to environmental problems. The pond waste management is a major concern of the shrimp farmers. In coastal habitat, sea cucumbers, *Holothurian* spp. feed on nutrient rich detritus in sediments and therefore play a major role in recycling of nutrients and bio-turbation of sediments. MacTavish *et al.* (2012) studies deposit-feeding sea cucumbers enhance mineralization and nutrient cycling in organically enriched coast al sediments. The potential co-culture of sea cucumber, *Holothurian* spp. with shrimp provides opportunity for bioremediation of pond wastes. James *et al.* (1994) studied the sea cucumber resources of India and also successfully bred *H. scabra*. James *et al.* (2002); Pitt *et al.* (2004) and Purcell *et al.* (2006) studies the possibilities of co-culture of shrimp with sea cucumber and emphasised the need of further investigation with regards to waste management in the culture ponds. Slater and Carton (2007) studied survivorship and growth of the sea cucumber *Australostichopus (Stichopus) mollis* (Hutton, 1872) in polyculture trials with green-lipped mussel farms.

The'black teatfish' *H. moebii*, the tropical sea

cucumber species, inhabits sandy and muddy coastal habitats and susceptible easily accessed shallow water stock of concern. This species has been produced in relatively small numbers for experimental work, but no technical constraints impede large-scale production (Battaglene and Bell, 2006). Sandfish are cultured in tanks until they reach 1g in weight, when they are grown on sand or muddy substrates (Battaglene, 1999; Battaglene *et al.*, 1999 and Pitt, 2001), but their growth soon becomes density limited (Battaglene *et al.*, 1999). Grow-out of sandfish in earthen ponds could effectively provide the large area needed to grow them to larger juvenile sizes for restocking into the wild (Pitt, 2001; Pitt and Duy, 2004 and Purcell, 2004), but the cost of earthen ponds is a constraint. Alternatively, growing sandfish juveniles in existing shrimp ponds could be cost effective because pond costs and management are already met. The use of shrimp waste would save costs of producing sea cucumbers of larger sizes, an approach shown to improve the cost effectiveness of growing American oysters (Jakob *et al.*, 1993).

Shrimp farming industry in got set back due to environment problems caused by the change in ecosystem and however, comes a threat to marine ecosystems from excessive deposition of organic material to the seabed. The addition of organic matter, either as shrimp food and feces, benthic environments contribute both directly (primary and secondary production) and indirectly (through nutrient regeneration) to ecosystem energetic (Soetaert *et al.*, 2000) and provide habitat for benthic organisms and many pelagic organisms at various stages of their lifecycle (Marcus and Boero, 1998). Thus, maintaining the resilience of benthic habitats around aquaculture farms is a key goal and challenge for resource managers (Goldburg and Naylor, 2005).

This study evaluated the co-culture of shrimp and sea cucumber for biological waste management of the shrimp ponds.

RESEARCH METHODS....................................

The experiment was conducted at Wadamirya hatchery of the Marine Biological Research Station, Ratnagiri, Maharashtra. Sea cucumbers, *H. moebii* (weight: 79.35 ± 0.013 g) were collected from sea beach Alawa, Ratnagiri. White leg shrimps, *L. vannamei* (weight: 2.6 ± 0.18 g) hatchery produced obtained from Chennai, Tamil Nadu. Sea cucumber and shrimp were initially acclimatised for 15 days at laboratory and were used for experiment. The experiment was conducted in 100 l capacity plastic tub for 30 days. The tubs were filled with double sand-filtered seawater. The bottom of each tub was covered with a 5 cm layer of pond soil. *H. moebii* was stocked one number per tub while shrimps were stocked at 10 numbers per tub. The shrimps were fed with commercial shrimp feed (40% protein) at 10 per cent of the body weight.

50 per cent water was exchanged weekly with double sand-filtered seawater. Water quality parameters such as temperature, pH, dissolved oxygen and salinity were recorded at daily. The water analysis was carried out following the procedures described by APHA (1998). During the experimental period, the initial and final organic carbon content of the soil were estimated as per McLeod (1973).

Student's t test was applied to determine the significance of difference between mean values in the experiment (Snedecor and Cochran, 1967).

RESEARCH FINDINGS AND ANALYSIS...........

During the experimental period water parameters such as temperature, pH and dissolved oxygen were recorded and found within tolerance limit *i.e.* Temperature (27 to 29^0 C), pH (8.2 to 8.4) Salinity (33-35 ppt) and Dissolved oxygen (4.6 to 5.2 ppm). Asha *et al.* (2011) suggested high survival, growth rate and fastest development of sea cucumber were obtained at salinity between 33 and 35 ppt. James *et al.* (2002) recorded salinity ranged from 28 to 40 ppt and the temperature from 24 to 29^0 C during culture of sea cucumbers in prawn farms.

The soil parameters such as pH and organic carbon were given in Table 1. The initial organic carbon of the soil was 0.85 per cent observed while at the end of experiment, bottom soil organic carbon was 0.94 per cent in the monoculture of shrimp whereas in the co-culture organic carbon of soil was 0.69 per cent. The t-test showed significant difference ($p<0.05$) in soil organic carbon between monoculture and co-culture. Thus the result of the present experiment showed agreement with James *et al.* (2002). Purcell *et al.* (2006a) reported organic content of sediments were declined in most tanks over the co-culture experiment of sea cucumber and blue shrimp. MacTavish *et al.* (2012) also demonstrated the functional role and potential of sea cucumbers to

Table 1 : Soil parameters of monoculture and co-culture

Particulars	Monoculture	Co-culture
Initial pH	8.10	8.10
pH after 30 days	7.92	7.93
Initial organic carbon	0.85 %	0.85 %
Organic carbon after 30 days	0.94 %[a]	0.69 %[b]
	$\pm$ 0.0054	$\pm$ 0.0067

The results is significant at $p < .05$

Table 2 : Growth and survival in monoculture and co-culture

Particulars	Monoculture	Co-culture
Initial average weight (g)	2.6 ± 0.18 g	2.6 ± 0.18 g
Avg. weight after 30 days (g)	3.36[a]	3.43[a]
	±0.0879	± 0.119
Percentage gain in weight	29.23	31.92
Survival (%)	73[b]	70[b]
	± 2.04	± 2.44

The result of growth is not significant at $p < .05$
The result of survival percentage is not significant at $p < .05$

ameliorate some of the adverse effects of organic matter enrichment in coastal ecosystems.

During present study, the low organic carbon percentage in co-culture, as sea cucumbers were extracting and assimilating organic matters from the sediments. Sandfish juveniles, both wild and hatchery produced, burrow in sediments during the early morning and surface around mid-day to commence foraging on sediments (Mercier *et al.*, 1999 and Mercier *et al.*, 2000). This behaviour is thought to have arisen as a form of protection against diurnal predators (Mercier *et al.*, 1999). Sandfish juveniles that are handled appear to subsequently burrow more frequently (Purcell *et al.*, 2006b). The increasing trend in the percentage of organic carbon in monoculture tub soil was due to feed waste and excretory matter.

At the end of rearing period, the shrimp growth and survival were given in Table 2. Shrimp weight was 2.6 g to 3.36 g in monoculture and from 2.6 g to 3.43 g in co-culture. The growth of shrimp was not significantly different between treatments, but shrimp grew significantly faster in co-culture ($p<0.05$). Thus the result of the present experiment showed agreement with Purcell *et al.* (2006a). Survival of shrimp and sandfish was high in all treatments (70–100%) and similar survival recorded by Purcell *et al.* (2006a).With help from the support to brackish water and marine aquaculture (SUMA) programme of DANIDA, the scientist of the Research Institute for Aquaculture number 3 (RIA 3) carried out a series of experiments in earth ponds and small scale containers to look at the feasibility of co-culture of sand fish with *Penaeus monodon* shrimp (Thu, 2003). Zhou *et al.* (2006) also reported high survivorship of *A. japonicus* when co-cultured with bivalves. *A. japonicus* is also grown in polyculture on a commercial scale with shrimp in land-based ponds in China, although there is no information available regarding the ecological benefits of this practise (Yaqing *et al.*, 2000). However, Zhou *et al.* (2006), co-cultured sea cucumbers in bivalve lantern nets above the seabed, as such, the sea cucumbers were isolated from the conditions prevailing beneath the farm. Pitt *et al.* (2004) reported similar growth rates (max 0.3 g d^{-1}) for *H. scabra* fed shrimp starter food, with growth limitation occurring at 300 g m^{-2} while Zhou *et al.* (2006) report growth rates between 0.15 and 0.26 g d^{-1} for *S. japonicus* when co-cultured at varying densities in scallop lantern nets.

Conclusion :

In the present investigation, Laboratory study suggests that sea-cucumber reducing the percentage organic carbon in the soil. Growth of shrimp did not differ between monoculture and co-culture. Results also show the acceptability of sea cucumber culture impacted sediments as a improvement of soil condition of pond. These results indicated that sea cucumber is a suitable candidate for polyculture with shrimp.

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COOPTED AUTHORS' –

R.D. BONDRE, H. SINGH, S.Y. METAR AND S.B. SATNAM, Marine Biological Research Station, Zadgaon, RATNAGIRI (M.S.) INDIA

R. PAI AND A.D. ADSUI, College of Fisheries, Shirgaon, RATNAGIRI (M.S.) INDIA

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